Investig. Report

32

#3

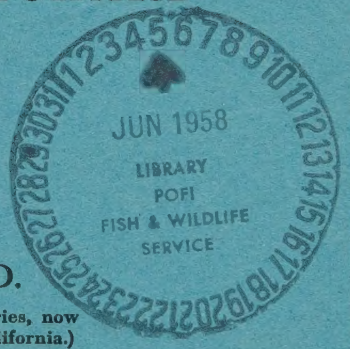
UNION OF SOUTH AFRICA

DEPARTMENT OF COMMERCE AND INDUSTRIES

DIVISION OF FISHERIES
INVESTIGATIONAL REPORT No. 32

THE BIOLOGY OF THE SOUTH AFRICAN PILCHARD

(Sardinops ocellata)



BY

D. H. DAVIES, M.Sc., Ph.D.

(Senior Professional Officer, Division of Fisheries, now *Institute of Marine Resources*, University of California.)

THE GOVERNMENT PRINTER, PRETORIA.

1957

G.P.-S.2351078—1957-8—1,200.

Reprint from "Commerce & Industry". DECEMBER, 1957

DEPARTMENT OF COMMERCE AND INDUSTRIES

THE BIOLOGY OF THE SOUTH AFRICAN PILCHARD

(Sardinops ocellata)

BY

D. H. DAVIES, M.Sc., Ph.D.

(Senior Professional Officer, Division of Fisheries, now *Institute of Marine Resources*, University of California.)

INVESTIGATIONAL REPORT No. 32

Issued by the Division of Fisheries, Beach Road, Sea Point, Cape Town

Union of South Africa

Contents.

		PAGE.
1.	Introduction	4
2.	Taxonomy and Description	6
3.	Distribution	6
4.	Associated Species	6
5.	Reproduction	7
6.	Size, Growth and Age	8
7.	Feeding	9
8.	Migration	9
9.	Disease	9
10.	Predators	9
11.	Commercial Importance	10
12.	Acknowledgments	10
13.	Bibliography	11

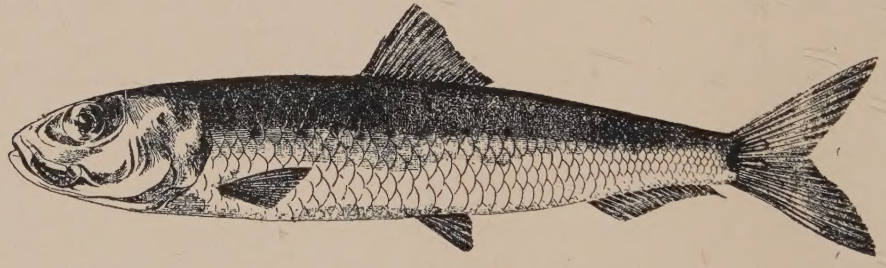
2351078—2.

1. Introduction.

The commercial exploitation of the South African Pilchard (*Sardinops ocellata*) began when a cannery and a fish meal and oil plant started operations at Lambert's Bay (see Fig. 2) on the West coast of the Union of South Africa in 1943. The total catch for the first season (1943–44) was 5,500 tons of fish. The pilchard industry grew rapidly and by 1950 there were thirteen factories operating along the West coast with an annual catch of over 80,000 tons of pilchards.

Due to this rapid expansion precautionary measures were taken to arrest the development of the fishery with the object of preventing serious damage being done to the stocks, and in 1950 a closed season for pilchard fishing was introduced and special legislation promulgated which prohibited the erection of more fish-meal factories. These measures had the effect of preventing further expansion and provided an opportunity for the implementation of an extensive research programme specially drawn up for the purpose of investigating the general biology and environment of the pilchard. By this means it was hoped that the pilchard industry could continue to operate without irreparable damage being caused to the West coast pilchard population, while at the same time scientific knowledge was accumulated as rapidly as possible in order to provide a background for new controlling legislation.

In 1950 a comprehensive investigation into the biology and environment of the South African pilchard was started under the name of *The Pilchard Research Programme*. The operation of this programme involved the utilisation of the entire resources of the Division of Fisheries, which at that time consisted of the following: a staff consisting of a Director and 12 scientific officers, two technical assistants, seven administrative and clerical personnel, and 14 ships' officers; headquarters offices and laboratories, two field stations and three research vessels. The programme has continued up till now (1957) and has undergone considerable expansion in many directions. The present resources of the Division consist of a staff composed of a Director and 24 scientific officers, five technical officers, nine administrative and clerical personnel and 15 ships' officers; headquarters offices and laboratories including an additional biological block, one field station (double the size of the two field stations operating in previous years) and three research ships. A further research block will shortly be constructed.



After Gilchrist

FIG. 1. THE SOUTH AFRICAN PILCHARD (Sardinops ocellata)

Government Printer,1957.

During 1957 the scope of the Pilchard Research Programme was even further increased by the combination of the research resources of the Division of Fisheries with those of the Fisheries Section of the Administration of South West Africa located at Walvis Bay. In this year the Pilchard Research Programme became the Pilchard/Maasbanker Combined Research Programme, the original programme having been previously extended in 1951 to include the maasbanker (*Trachurus trachurus*), a pelagic species of similar commercial importance. The organization of a combined research programme has resulted in the provision of an *additional* research station, four scientific officers, one technical officer, seven ships' officers and three research vessels.

The research vessels of the Division of Fisheries used in the Pilchard Research Programme up to 1957 were R.S. *Africana II*, R.V. *Schipa* and P.B. *Palinurus*.

R.S. *Africana II* is a modern research ship of 1,300 tons displacement built in the United Kingdom in 1948-49 and delivered in South Africa in

1950. This ship is of the trawler type, has an overall length of over 205 feet and a cruising speed of 10 knots. *Africana II* is equipped with a large biological and hydrological laboratory situated amidships three feet above the level of the main deck, and has two deck winches for operating hydrological gear and vertical plankton nets together with a torpedo-type davit mounted aft on the boat deck in conjuction with a scientific winch for the operation of horizontal plankton tow-nets. A full description of this vessel has been published (Marchand, Shannon and Clark, 1951).

R.V. *Schipa* is a modified Fairmile type ex-naval rescue launch of total length 108 feet and with a cruising speed of 12 knots. The *Schipa* has a small deck laboratory and is used for inshore horizontal plankton tow-netting and the taking of surface temperatures.

P.B. *Palinurus* is a patrol boat of total length 50 feet designed on the lines of the local motor fishing vessels and with a cruising speed of nine knots. Although this vessel lacks any sort of laboratory it is possible to work horizontal plankton tow-nets, take surface temperatures and operate a lampara net for catching pilchards for purposes of tagging on board the vessel in a very satisfactory manner. Both *Palinurus* and *Schipa* were used in operations to collect juvenile fish by means of explosives and also in the shooting of predatory sea-birds.

In the near future both *Schipa* and *Palinurus* will be replaced by two new research vessels designed by the Division of Fisheries of the Food and Agricultural Organization of the United Nations. These vessels are being specially built for pelagic fisheries research and each will be equipped with a modern laboratory and suitable deck gear for vertical and horizontal hydrological and biological work, as well as for the operation of lampara and blanket-nets.

An additional vessel of larger size, viz. 120 feet in overall length is also to be built in the near future. This vessel will be equipped for all types of hydrological and biological work at sea and will be capable of doing oceanographic work similar to that carried out at present by *Africana II*. With the use of this vessel the off-shore work will be considerably extended.

In 1950 two field laboratories or shore stations were established, the one situated at Lambert's Bay and the other at Stompneusbaai (see Fig. 2). Each laboratory was staffed by a single biologist whose main duties were to take and examine pilchard samples and to examine the plankton samples collected by the two small vessels. In 1953 the shore station at Lambert's Bay was closed and two biologists stationed at Stompneusbaai in place of one. In 1955 a new, enlarged field laboratory was built.

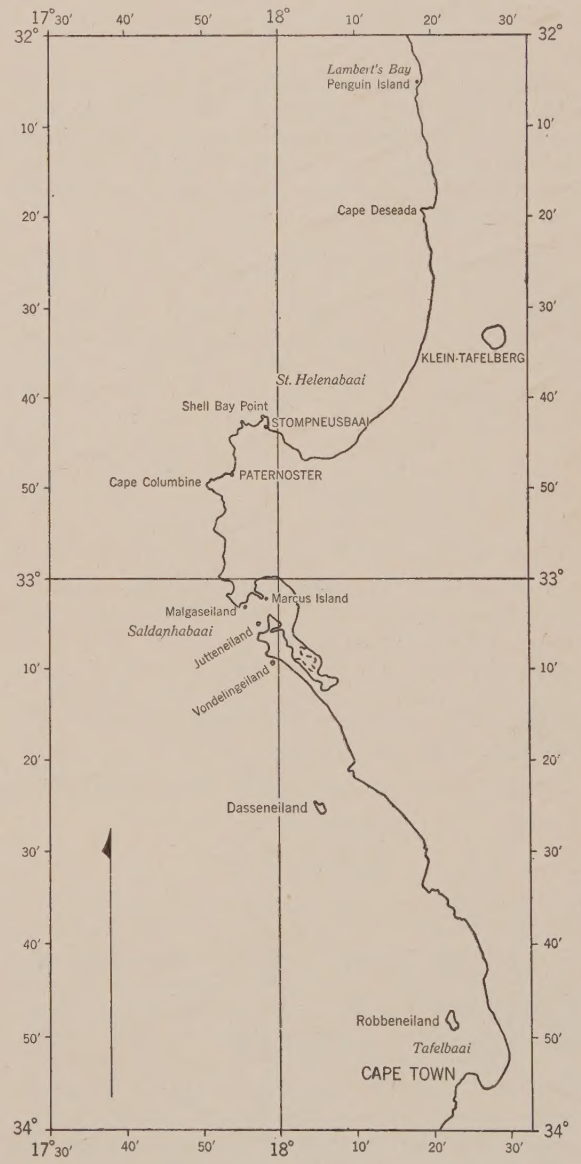


FIG. 2 THE WEST COAST

Trigsurvey, 1956. Government Printer, 1956.

Having given some idea of the general organization and background of the research into the biology, bionomics and environment of the South African pilchard, it may be stated that *the greater part of the contents of this paper has already been published in the form of separate investigational reports dealing with the various aspects of the biology of the pilchard. The main object of this report is to present these findings as an integrated whole.*

2. Taxonomy and Description.

The South African pilchard, *Sardinops ocellata* (Pappe) (see Fig. 1), belongs to the family *Clupeidae* and is closely allied to species such as the California sardine, *Sardinops caerulea* (Girard), the Australian pilchard, *Sardinops neopilchardus* (Steindachner) and other species.

The body of the pilchard is elongate, rounded rather than compressed and has feeble scutes along the belly. The pilchard has no teeth and has two enlarged scales at the base of the caudal, which is forked. The scales are very deciduous. Depth five in length. Interorbital equals eye. Adipose eyelid present. Dorsal 17–19 rays, anal 18–20 rays. No lateral line. Lateral series of scales 50–55, transverse 12, scutes 18–20 anterior to pelvics, 12–15 posterior to pelvics. Gill-rakers 100–115, long and slender with lateral processes for fine filtration. Attains 30·5 cm. total length.

Considerable natural variation in colour occurs. The dorsal surface varies from dark green, light green, light blue to dark blue. The dark spots along the sides are at times most marked and at other times hardly visible. They are nearly always visible when the scales have been removed. The belly region is silvery white.

There are no obvious external sexual differences.

3. Distribution.

(a) General.

The South African pilchard occurs from Baia dos Tigres in Angola right round the coast to Durban in Natal (see Fig. 3). This represents a total range of over 2,000 miles.

(b) Local.

Although the South African pilchard has a very extensive range, its distribution is by no means even and large concentrations are found off Angola in the Baia dos Tigres area, off South West Africa, in the Walvis Bay area, in the St. Helena Bay area and off the Natal coast south of Durban in the waters of the Union of South Africa.

In the Baia dos Tigres, Walvis Bay and St. Helena Bay areas pilchards occur in large numbers during the greater part of the year and form the basis of very extensive commercial fisheries. The occurrence of large numbers of pilchards off the East coast is, however, limited to a short period in the month of June each year when large shoals migrate northwards as far as Durban and then disappear. During their passage along the Natal coast pilchards are caught in small numbers from the beaches with seine nets by Indian fishermen.

4. Associated Species.

During the course of the pilchard research programme a large variety of different types of gear was operated off the West coast of the Union. The gear operated at various times included vertical and horizontal plankton nets of different sizes, a 2 metre young fish trawl, a 90 feet otter trawl, various set-nets, larva traps, lampara nets, explosive charges used in conjunction with dredge nets, scoop nets, blanket-nets and handlines. Over a period of years a great deal of data concerning the species found in association with the pilchard was obtained.

By far the most important of the species found associated with the pilchard off the West coast is the **Maasbanker** (*Trachurus trachurus*). The Maasbanker is a pelagic species belonging to the family *Carangidae* and it occurs in very large numbers in this area. The maasbanker together with the pilchard form the basis of the West coast fisheries.

Another species which occurs in large numbers but during short periods in the summer months only is the **Mackerel** (*Scomber japonicus*). Mackerel shoals frequently appear in the area in the months of January and February when pilchards and maasbankers are rare or entirely absent. In this way mackerel provide a useful stop-gap for the West coast factories.

Large shoals of **Anchovies** (*Engraulis japonicus*) occur off the West coast during the greater part of the year. No commercial exploitation of this species has yet been undertaken, but there is no doubt that the anchovy is a latent fishery resource of considerable importance as initial technological investigation has shown it to be suitable for products of the highest quality. The anchovies recorded in this area are mainly young and half-grown fish.

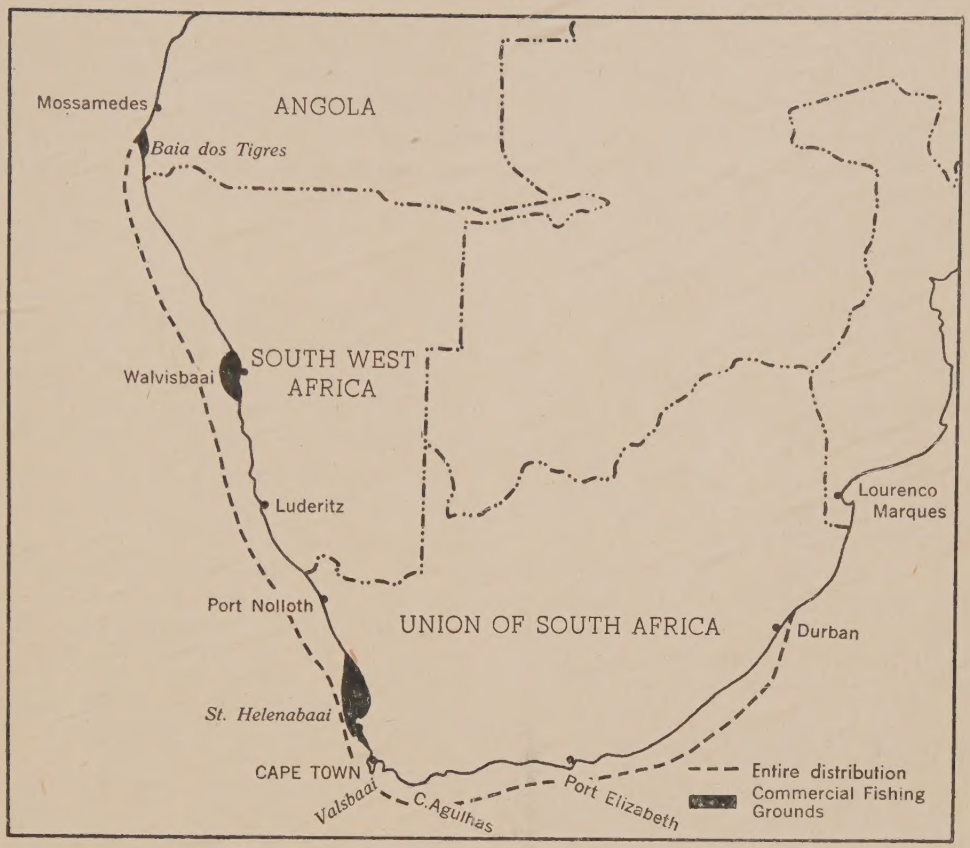


FIG. 3. DISTRIBUTION OF THE SOUTH AFRICAN PILCHARD

Trigsurvey,1957. Government Printer,1957.

The **Round Herring** (*Etrumeus micropus*) occurs from time to time in large shoals mainly during the spring and summer. Juvenile round herring are found throughout the year in well-sheltered bays such as Saldanha Bay.

The **Snoek** (*Thyrsites atun*) occurs off the West coast of the Union in large numbers each year during late autumn and the winter months of June and July. Snoek shoals are migrating south at this time and prey heavily on the pilchards during their passage through the area.

The **Skipper** (*Scomberesox saurus*) occurs in large numbers mainly off shore and out of the normal range of the pilchard. Juvenile skippers may, however, appear in large numbers close inshore.

Young **Stockfish** (*Merluccius capensis*) are frequently found in association with pilchard shoals and adult stockfish prey on pilchards whenever they migrate to off-shore waters.

Shoals of **Silversides** or **Vlei** "Sardines" (*Atherina breviceps*) are frequently found in the shallow waters of protected bays in the company of juvenile pilchards.

5. Reproduction.

(a) The Egg.

The egg of the South African pilchard is very similar in general appearance to that of the California sardine (*Sardinops caerulea*), the main dfferences being dimensional. The egg is spherical with a smooth vitelline (fertilisation) membrane and a large perivitelline space. The yolk is small and irregularly segmented and gives the impression of having a mosaic pattern. There is a single oil globule of diameter 0·18 mm. The diameter range of the egg from just before spawning to the time of hatching is 1·17 mm–1·91 mm, but the mean ova diameter for all eggs collected in the plankton at sea was 1·70 mm.

The blastodermal cap is large, rounded and appears much darker and more dense than the yolk. Throughout development the egg remains buoyant and floats at or near the surface.

The larva develops rapidly within the egg and the somites are easily visible. Just before hatching it is much elongated and very lively. A double row of black pigment spots or melanophores extends from the dorsal region of the head of the larva along its entire length on either side of the dorsal fin.

(b) The Larva.

After hatching the larva is held to the surface in an inverted position by the yolk sac and oil globule. At first it floats helplessly but soon begins to swim with short bursts of rapid tail movement. After each burst, however, it returns to the surface. The total length of the larva immediately after hatching is 3·6 mm.

A detailed description of the development, pigmentation, etc. of the larva and post-larva has been given (Davies, 1954).

The metamorphosis from post-larva to juvenile takes place between lengths of 30–35 mm.

(c) Numbers of Eggs per Female.

On the basis of counts made on gonads preserved in 10 per cent formalin it was established that the average number of ova spawned per female pilchard per season is approximately 95,000 ova.

(d) Sex Ratio.

The mean ratio of male to female pilchards in the commercial catches off the West coast area is 44:56, i.e. there is a constant predominance of females over males by 12 per cent.

An analysis of this ratio of sexes in relation to length group showed that there is an initial preponderance of males up to 22 cm standard length and a subsequent preponderance of females from 22 cm onwards. This is no doubt due to a difference in the rate of growth of pilchards just after the juvenile stage.

(e) Spawning Season.

Spawning in the South African pilchard may take place to a limited degree throughout the year. The main spawning season although not rigidly fixed extends from September to February each year. The intensity of spawning within this period of greatest activity is by no means constant and spawning sub-maxima may occur, particularly in September and February. This variation in the intensity of spawning recorded in the vicinity of the commercial fishing area is probably due to the fact that individual shoals of pilchards do not spawn simultaneously.

Large pilchards spawn later than smaller ones.

(f) Spawning Area.

Although spawning takes place to some extent in the area of commercial fishing, the majority of pilchards move away just prior to spawning. As individual shoals reach spawning condition they migrate to the south and off shore and they may become widely dispersed before spawning.

Pilchards in the act of spawning are not normally caught in the commercial fishing area.

(g) Spawning Conditions.

Pilchard eggs were recorded between temperatures of 11·9°C and 21·7°C but main spawning occurs within a temperature range of 13·8°C–16°C, a salinity range of 35·1°/$_{oo}$–35·4°/$_{oo}$ and at depths between 0 metres and 20 metres.

6. Size, Growth and Age.

The commercial catches of pilchards off the West coast of the Union are dominated by certain size-groups which pass through the fishery. These size-groups fall mainly within the limits of standard lengths 21–24 cm and are sexually mature fish.

Juvenile pilchards are present off the West coast in largest numbers during the spring and summer and are widely dispersed. They are rarely caught in the commercial catches.

Although growth studies for the pilchard are incomplete, a tentative estimate of the rate of growth of male and female fish between standard lengths of 20·5 cm and 22·4 cm is given as 0·5 cm per year. The rate of growth of juvenile pilchards between standard lengths of 3 cm and 8 cm may be as high as 0·8 cm per month.

Age determination studies in progress indicate that the commercial catches of pilchards probably consist mainly of 3–5 year old fish, while two year-olds together with six and seven year old fish occur in smaller numbers.

7. Feeding.

The South African pilchard is primarily a filter feeder but may also be a particulate feeder. Its food off the west coast of the Union consists entirely of plankton. Phytoplankton is eaten to a far greater extent than zooplankton and the pilchard shows an apparent preference for diatoms. Of the zooplankton eaten, copepods are the most important group.

8. Migration.

Pilchards are found in greatest abundance in the commercial fishing area off the West coast during the period March to July each year. They move away from this area from August through spring and early summer for purposes of spawning. This migration takes the form of successive departures of individual shoals and no mass migration takes place. During the spawning season pilchard shoals are widely dispersed and occur mainly to the south of the fishing grounds and off shore.

The presence of the pilchards in commercial fishing areas such as St. Helena Bay and Walvis Bay, and probably Baia dos Tigres as well, is related to the high productivity of these areas. There is no doubt that these bays provide shelter and rich feeding for non-spawning fish.

No clear relationship between the presence of pilchards and water temperatures off the West coast is apparent, but a definite relationship between wind and the movement of pilchard shoals in the commercial fishing grounds was found. In summer, when the incidence and velocity of southerly winds are high, pilchards are absent from the area and during winter when most winds come from the north and velocities are generally low, pilchards are present in greatest abundance.

During summer and autumn when the incidence of southerly winds is high, pilchard shoals generally occur off shore. During winter and early spring when the incidence of southerly winds is low, pilchard shoals generally occur close inshore.

In general, small, mainly sexually-immature pilchards are concentrated off the south and east coasts and larger, mainly sexually-mature fish occur to the north off the West coast in the St. Helena Bay region.

The pilchards occurring in Walvis Bay are smaller than those of St. Helena Bay and a large proportion is probably immature.

No satisfactory explanation has so far been given for the annual migration of pilchards along the East coast off Natal during June each year. These shoals consist of small, mainly immature, pilchards which move northwards close to the shore as far as Durban and then disappear. Their migration has no apparent connection with either feeding or spawning. It is thought that they return to the Cape along a deeper, off-shore route and with the assistance of the strong southerly Agulhas current.

An extensive tagging programme recently started at Walvis Bay, St. Helena Bay and False Bay, with the main object of establishing the connections between the various pilchard populations, has so far shown that pilchards move from Hout Bay to False Bay.

9. Disease.

Freshly-caught pilchards seldom show any signs of disease but it is interesting to note that a very high percentage of fish become infected with a protozoan of the order *Myxosporidia*. This organism, *Chloromyxum thyrsites*, occurs in the muscular tissue and does not apparently do any serious damage to the living fish. Shortly after death, however, it causes the slow disintegration and liquefaction of the somatic muscle which in time renders the fish quite unfit for canning or processing.

Pilchards caught and transported alive for exhibition in the public aquarium or for experimental work, are easily damaged and are liable to fungus and bacterial infection. Undamaged fish remain healthy and live for considerable periods in confinement.

10. Predators.

The pilchard has many predators, including mammals, birds and fishes.

Among mammals, man is the most important predator as he catches approximately 130,000 tons of pilchards a year off the coast of the Union of South Africa and up to 250,000 tons annually off the coast of South West Africa. The large populations of Cape Fur Seals (*Artocephalus pusillus*) living round the South African coast consume considerable quantities of pilchards and from time to time porpoises feed extensively on pilchard shoals.

Although a large number of sea-birds prey on pilchards whenever the opportunity occurs, the main bird predators of the South African pilchard are the Gannet (*Morus capensis*), the Cape Cormorant (*Phalacracorax capensis*) and the Cape Penguin (*Spheniscus demersus*). These three species consume at least 43,000 tons of pilchards a year off the West coast of the Union alone.

Among the fish predators of the pilchard, Snoek (*Thyrsites atun*), Stockfish (*Merluccius capensis*), Tunny (*Thynnus thynnus*) and Spanish Mackerel (*Scomberomorus commerson*) are the most important. The snoek preys heavily on pilchards during its annual migration along the West coast, the stockfish preys on pilchards when the latter move off shore for spawning and the tunny and Spanish mackerel take a heavy toll of pilchards during their annual migration up the East coast.

Among the important predators of juvenile pilchards are adult Maasbankers (*Trachurus trachurus*) and Squid (*Loligo reynaudi*), which consume large numbers of juvenile pilchards in sheltered areas such as Saldanha Bay.

11. Commercial Importance.

During the last six years (1951–56) the annual commercial catches of pilchards off the West coast of the Union of South Africa varied from 84,175 tons to 187,424 tons giving an average of 127,326 tons. The price obtained by the fisherman for landed pilchards averages £4·5 a ton giving an average landed value of £573,000, worth nearly £3,000,000 in terms of final fishery products, which are canned fish, fishmeal and fish-body oil.

The average annual pilchard catch for South West Africa is nearly twice that of the Union, viz. 250,000 tons, with a landed value of over £1,000,000 and a final value of over £5,000,000.

The pilchard is one of the most important species in the fisheries of South Africa.

12. Acknowledgments.

I am indebted to Dr. J. M. Marchand, Director of Fisheries, and my colleagues of the Division of Fisheries for reading and criticising this paper.

13. Bibliography.

BARNARD, K. H., 1927—*Monograph of the Marine Fishes of South Africa.* Ann. of S.A. Museum, XXI, pp. 1–1065. Cape Town.

BUYS, M. E., 1957—*The South African Pilchard (Sardinops ocellata). Temperature Variations in the Upper 50 metres in the St. Helena Bay Area, September, 1950–August, 1954.* Dept. of Comm. and Indust., Div. of Fish., Invest. Rep. No. 27. In press. Pretoria.

CLOWES, A. J., 1954—*The South African Pilchard (Sardinops ocellata). The Temperature, Salinity and Inorganic Phosphate Content of the Surface Layer near St. Helena Bay,* 1950–52. Dept of Comm. and Indust., Div of Fish., Invest. Rep. No. 16, pp. 1–47. Pretoria.

DAVIES, D. H., 1954—*The South African Pilchard (Sardinops ocellata). Development, Occurrence and Distribution of Eggs and Larvae,* 1950–51. Dept. of Comm. and Indust., Div. of Fish., Invest. Rep. No. 15, pp. 1–28. Pretoria.

DAVIES, D. H., 1954—*The South African Pilchard (Sardinops ocellata). Bird Predators,* 1953–54. Dept. of Comm. and Indust., Div. of Fish., Invest. Rep. No. 18. pp. 1–32. Pretoria.

DAVIES, D. H., 1956—*The South African Pilchard (Sardinops ocellata). Sexual Maturity and Reproduction,* 1950–54. Dept. of Comm. and Indust., Div. of Fish., Invest. Rep. No. 22, pp. 1–155. Pretoria.

DAVIES, D. H., 1956—*The South African Pilchard (Sardinops ocellata) and Maasbanker (Trachurus trachurus). Bird Predators,* 1954–55. Dept. of Comm. and Indust., Div. of Fish., Invest Rep. No. 23, pp. 1–40. Pretoria.

DAVIES, D. H., 1956—*The South African Pilchard (Sardinops ocellata). Migration,* 1950–55. Dept. of Comm. and Indust., Div. of Fish., Invest. Rep. No. 24, pp. 1–52. Pretoria.

DAVIES, D. H., 1957—*The South African Pilchard (Sardinops ocellata). Size Composition of the Commercial Catches,* 1950–55. Dept. of Comm. and Indust., Div. of Fish., Invest. Rep. No. 26, pp. 1–57. Pretoria.

DAVIES, D. H., 1957—*The South African Pilchard (Sardinops ocellata) and Maasbanker (Trachurus trachurus). Young Fish Survey,* 1955–56. Dept. of Comm. and Indust., Div. of Fish., Invest. Rep. No. 29. In press. Pretoria.

DAVIES, D. H., 1957—*The South African Pilchard (Sardinops ocellata). Preliminary Report on Feeding off the West Coast,* 1953–56. Dept of Comm. and Indust., Div. of Fish., Invest. Rep. No. 30. In press. Pretoria.

DAVIES, D. H., 1957—*The South African Pilchard (Sardinops ocellata) and Maasbanker (Trachurus trachurus). The Predation of Sea-birds in the Commercial Fishery.* Dept. of Comm. and Indust., Div. of Fish., Invest. Rep. No. 31. In press. Pretoria.

DE JAGER, B. v. D., 1954—*The South African Pilchard (Sardinops ocellata). Plankton Studies in and Around St. Helena Bay,* 1950–51. Dept. of Comm. and Indust., Div. of Fish., Invest. Rep. No. 17, pp. 1–26. Pretoria.

DE JAGER, B. v. D., 1955—*The South African Pilchard (Sardinops ocellata). The development of the Snoek (Thyrsites atun). A Fish Predator of the Pilchard.* Dept. of Comm. and Indust., Div. of Fish., Invest. Rep No. 19, pp. 1–16. Pretoria.

DE JAGER, B. v. D., 1957—*The South African Pilchard (Sardinops ocellata) and Maasbanker (Trachurus trachurus). Variations in the Phytoplankton of the St. Helena Bay Area during* 1954. Dept. of Comm. and Indust., Div. of Fish., Invest. Rep. No. 25, pp. 1–77. Pretoria.

FOWLER, H. W., 1936—*Fishes of the Philippine Islands and Adjacent Seas.* U.S. Nat. Mus. Bull. 100, 13, pp. 622–624. Washington.

FOWLER, H. W., 1936—*The Marine Fishes of West Africa.* Bull. Amer. Mus. Nat. Hist., LXX, I, pp. 1–605. New York.

GILCHRIST, J. D. F., 1913—*Review of the South African Clupeidae (Herrings) and Allied Families of Fishes.* Mar. Biol. Rep., No. 1, pp. 46–66. Cape Town.

GILCHRIST, J. D. F., 1916—*Eggs and Larvae of Cape Fishes.* Mar. Biol. Rep., No. 3, pp. 20–21. Cape Town.

HART, T. J. and MARSHALL, N. B., 1951—*Breeding Ground of Pilchards off the Coast of South-West Africa.* Nature, CLXVIII, pp. 272–273. London.

MARCHAND, J. M., 1950–57—*Annual Reports of the Division of Fisheries, Nos.* 22–27, Dept. of Comm. and Indust., Div. of Fish., Pretoria.

MARCHAND, J. M., SHANNON, R. L. V. and CLARK, A., 1951—*The Fisheries Research Ship "Africana II".* Dept. of Comm. and Indust., Fish. and Mar. Biol. Survey Div., Fish. Bull. No. 3, pp. 1–47. Pretoria.

NEPGEN, C. DE V., 1957—*The South African Pilchard (Sardinops ocellata) and Maasbanker (Trachurus trachurus). The Euphausiids of the West Coast of South Africa.* Dept. of Comm. and Indust., Div. of Fish., Invest. Rep. No. 28. In press. Pretoria.

ROWAN, M. K., 1956—*Chloromyxum thyrsites in Various South African Fishes.* Fishing Indust. Res. Inst., Ninth Ann. Rep., 1st April, 1955–31st March, 1956. pp. 1–37. Cape Town.

SMITH, J. L. B., 1949—*The Sea Fishes of Southern Africa.* pp. 1–550. Cape Town.

THOMPSON, W. W., 1916—*Catalogue of Fishes of the Cape Province.* Mar. Biol. Rep. No. 3, pp. 69–135. Cape Town.

VILELA, A. J., 1923—*A Pesca e industrias derivadas no Distrito de Mossamedes,* 1921–22. pp. 1–426. Porto.

VON BONDE, C. and DAVIES, D. H., 1951—*Breeding of Pilchards off the West Coast of South Africa.* Nature, 168, No. 4283, pp. 952–953. London.